# Econ435 – Financial Markets and the Macroeconomy
# Problem Set 4

## Due: Monday, August 20

## Question 1

Mr. and Mrs. Smith plan to buy a house in the near future. Their dream house costs $240,000 and will be available in a year. The Smiths currently hold $200,000 in 2,500 shares of company A. Their financial adviser tells them that they have three options to reach their goal:

(1) create a *protective put* by buying a put option on stock A, with an exercise price of $X_p = \$100$ and premium equal to $P = \$10$.

(2) create a *covered call* by selling a call option on stock A, with an exercise price of $X_c = \$95$ and premium equal to $C = \$8$.

(3) create a *collar* by buying a put option and selling a call option, both on stock A and both with the same premium, with exercise prices equal to $X_1 = \$96$ for the put option and $X_2 = \$102$ for the call option.

Please answer the following questions:

(i) What is the current price $S_0$ of the stock?

(ii) Derive the payoff of the protective put as a function of the future price of the stock $S_T$. Graph the total payoff and profit of this investment option (assuming that the only cost is the premium of the put option). What is the total value (profit) of this investment after one year, as a function of $S_T$? (Hint: Calculate the payoff and profit per share, like we did in class. The "total payoff" and "total profit" will be given by the per-share values multiplied by 2,500, the number of shares owned).

(iii) Derive the payoff of the covered call as a function of the future price of the stock $S_T$. Graph the payoff and profit of this investment option (assuming that the only cost is

the premium of the call option). What is the total value (profit) of this investment after one year, as a function of $S_T$?

(iv) Derive the payoff of the collar as a function of the future price of the stock $S_T$, using the payoffs of its components. Graph the payoff and profit of this investment option. What is the total value (profit) of this investment after one year, as a function of $S_T$?

(v) If you were the financial adviser of the Smiths and you expected the stock price of company A to fall during the year, which strategy would you recommend in order for them to afford the house? How would your recommendation change if you expected the stock price to increase? Which strategy would you recommend if the evolution of the price was uncertain?

## Question 2

The current price of stock A is $80, and the volatility of returns on the stock is given by $\sigma = 0.25$ (or 25% per year). The ongoing (risk-free) interest rate is $r = 0.10$, or 10% per year.

(i) What is the value of a European call option with 6 months until expiration date ($T = 0.5$) and exercise price $X = 75$? (Hint: you need to use the Black-Scholes formula. So, first calculate $d_1$ and $d_2$. Next, you need to find the values of $N(d_1)$ and $N(d_2)$, which you should find in (1) any statistics book, (2) by using the NORMSDIST function in Excel, or (3) in Table 1 at http://math.uc.edu/~brycw/classes/148/tables.htm by writing the values of $d_1$ or $d_2$ in the z-value box and pressing the ---> button, after making sure that Left tail is checked).

(ii) (*extra credit*) What is the value of a European put option with the same characteristics?

## Question 3

(*extra credit*) Stock A currently trades at $50 a share. At the end of the year, it can either be up by a factor $u = 1.3$ or down by a factor $d = 0.5$. What is the price of a one-year call option with exercise price $X = \$55$ if the (risk-free) interest rate is $r = 10\%$? (Hint: use the binomial model)